LRI
Long-Range
Research Initiative

cefic

Advancing Chemical
Safety Assessments

Cefic-LRI Projects

Completed 2024

LRI 2024
Closed Projects in Numbers

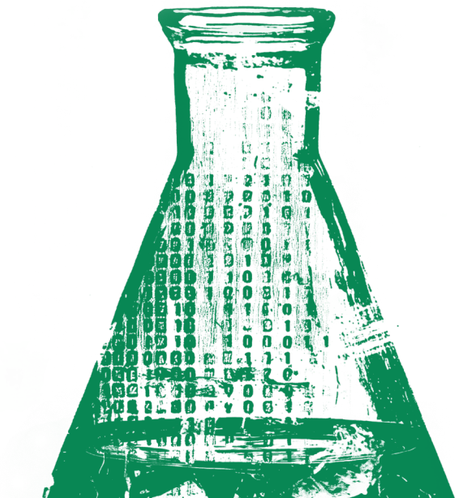
Since 1999, LRI, Cefic's Long-Range Research Initiative Programme has been addressing societal challenges with science to improve safety and sustainability of chemicals. LRI has awarded approximately €90 million to over 250 projects that address European public health strategy priorities.

These peer-reviewed and transparent studies are designed to:

- Understand everyday and occupational exposure to chemicals;
- Investigate the effects of exposure to chemicals on human health;
- Develop tools and approaches to improve chemical risk assessment;
- Reduce animal use in chemical testing.

LRI also addresses many of the environmental objectives of the EU, including:

- Linking environmental factors to health effects;
- Understanding and reducing chemical risks to the environment;
- Improving and advancing chemical risk assessment methods.



In 2024 Cefic-LRI completed

8 projects which were led by

21 research institutes

26 individual researchers

They focused on

Modeling fragmentation of micro- and nano-plastics in the environment

ECO59

FRAGMENT-MNP

Development of a Multimedia Unit World Open-source Model for Microplastic

ECO56

UTOPIA

Microplastic Long-range Transport Assessment and Estimation Tools

ECO57

µPLANET

Comprehensive Additive Release and Bioaccessibility Model for Risk Assessment of Micro- and Nano-plastics in the Environment

ECO58

A Tiered Strategy to Assess Microplastic Inhalation

C10

Developing a tiered modeling framework in support of risk assessment of chemical substances associated with mobility concerns

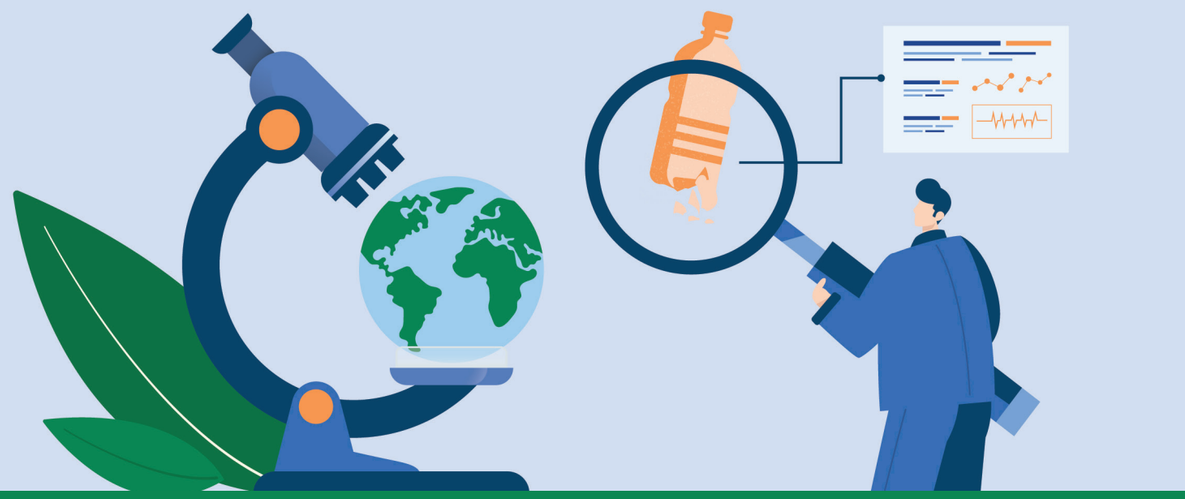
ECO54

Characterizing the uncertainty in MAF values for aquatic receptors estimated using the KEMI MAF

ECO65

Systematic literature review on analytical methods for the determination of PFAS

ANP1



€2,376,500 budget

6 tools

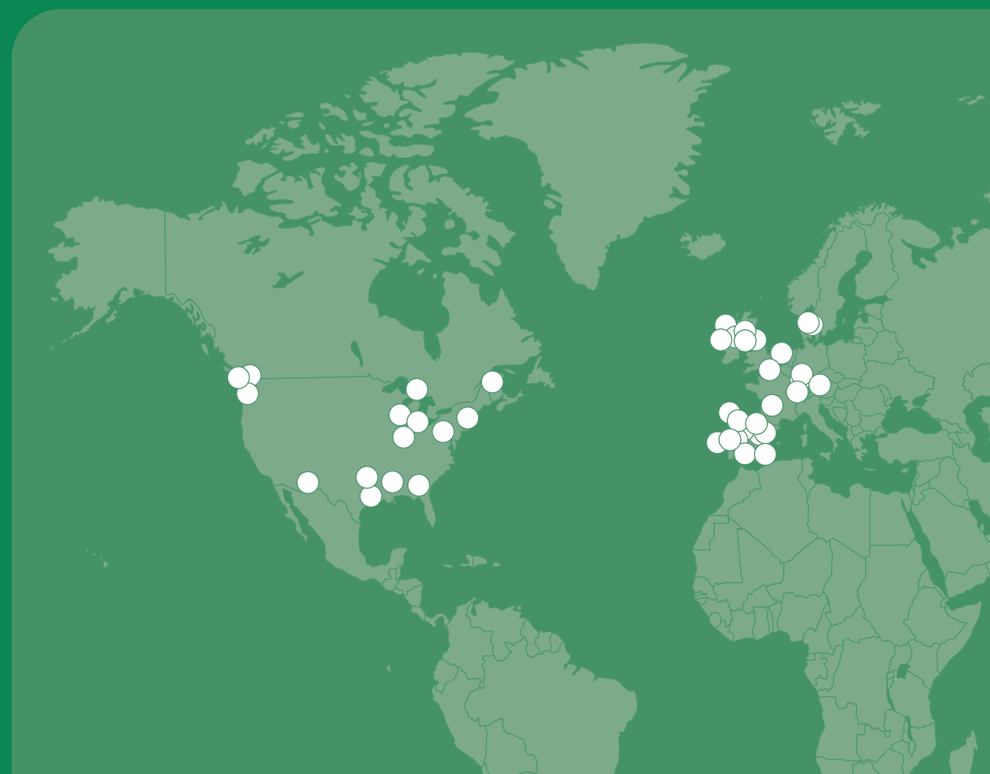
FRAGMENT-MNP	Modeling fragmentation of micro- and nanoplastics in the environment
UTOPIA	Open-source multimedia model for microplastics
µPLANET & µBETR	Long-range transport assessment tool for microplastics
PAC Release Model	Additive leaching and bioaccessibility model
PROTEX & RAIDAR	Tiered modeling for persistence and mobility

3 databases

Microplastic Property Database	UTOPIA model for microplastics
PAC (Polymer-Associated Chemicals) Database	Additive release model
PFAS Analytical Methods Literature Review	Systematic PFAS methods review
Fragment- Micro- and Nanoplastics (MNP) size particle concentrations	FRAGMENT-MNP

58 presentations

17 scientific publications



microplastic | fragmentation | degradation | environmental model

ECO59

FRAGMENT-MNP

Modeling fragmentation of micro- and nano-plastics in the environment

4 → Institutes

3 → Years

8 → Presentations

€250,000 → Budget

3 → Publications

An open-source model that predicts how environmental factors impact fragmentation and degradation of different polymer types.

HIGHLIGHTS

- Produced data on how seven common polymer types break down. This was done using a systematic approach to ensure a holistic assessment and an integrated, interoperable model.
- Demonstrated that fragmentation and degradation are dependent on both the polymer's properties and environmental factors such as UV exposure, temperature, pH, humidity, enzymes and mechanical forces.

FRAGMentation in the EnvironmeNT- Micro and NanoPlastic (FRAGMENT-MNP) is applicable across a range of environmental conditions and provides information on how particle size distributions evolve over time.

It is a mechanistic model, meaning it simulates real-world physical and chemical processes to explain how and why polymers break down in the environment. By bringing together elements of fundamental physical chemistry, fluid mechanics, materials science and data science, it advances our understanding of existing fragmentation theory. The model gives us a unified view of how key environmental factors affect degradation and fragmentation rates for polymer particles.

The project is designed with the aim to:

- Build a shared "LRI Cluster" by linking projects ECO56–59, ensuring that models, data, and concepts can be integrated and shared widely.
- Ensure interoperability with other models through the LRI Cluster.
- Develop an experimental database of key parameters required by the FRAGMENT-MNP model, using a combination of in-house databases, published literature, and targeted experiments designed to fill knowledge gaps. Many of these parameters are also shared with, or useful to, other projects in the LRI ECO56–59 Cluster.

The project results underline the need for models that can simultaneously simulate multiple polymer-related processes such as fragmentation, aggregation, sedimentation and additive release. To ensure exposure assessments accurately reflect plastic pollution, these process models should be embedded within exposure models, capturing the multidimensional nature of polymers. This integrated approach would advance our ability to perform robust, science-based risk assessments of (micro)plastics in the environment.

DISSEMINATION

most recent

1. *MICRO2024, Lanzarote, September 2024.* The fate of microplastics in the environment: Systematic studies to determine release rates of secondary micro- and nanoplastics and water-soluble organics induced by photolysis and hydrolysis.
2. *SETAC Europe, Seville, May 2024.* Predicting Plastic Degradation and Fragmentation in the Environment.
3. *SETAC Europe, Seville, May 2024.* Systematic comparison of environmental stresses (shear, humidity, UV, pH, temperature, enzymes) on microplastic fragmentation and release of nanoplastics and dissolved organics.

TIMELINE

2021 — 2022 — 2023 — 2024

October — September

RESEARCH TEAM

→ *Principal Investigator*
Dr Claus Svendsen, UKCEH

→ *Collaborators*
Dr. Wendel Wohlleben, BASF (DE)
Dr. Antonia Praetorius, University of Amsterdam (NL)
Dr. Mark Wiesner, Duke University (US)

PUBLICATIONS

→ Pfohl, P., Santizo, K., Sipe, J. et al. Environmental degradation and fragmentation of microplastics: dependence on polymer type, humidity, UV dose and temperature. Micropl.&Nanopl. 5, 7 (2025). https://doi.org/10.1186/s43591-025-00118-9

→ Harrison, S., Uluseker, C., Pfohl, P. et al.. FRAGMENT-MNP: A model of micro- and nanoplastic fragmentation in the environment. *JOSS. Submitted.*

→ Pfohl, P., Tantawi, O., Santizo, K. et al. Abiotic Hydrolysis of Microplastics: Particle Fragmentation Is Linked to Polymer Chain Scission Leading to Dissolved Organic Carbon Release. *Draft.*

microplastic | environmental risk assessment | open-source model

ECO56

UTOPIA

Development of a Multimedia Unit World Open-source Model for Microplastic

4 → Institutes

3 → Years

4 → Presentations

€250,000 → Budget

1 → Publication

An open-source, user-friendly model for microplastics risk assessment, designed for researchers, regulators and industry professionals.

HIGHLIGHTS

- Assessed how microplastics move, change or settle – their fate and transport – in different parts of the environment.
- Provided a user interface to make the model accessible to a wider community.
- Continues to evolve through ongoing development and student feedback, as part of the Cluster-up project (LRI-ECO68) since December 2024.

UTOPIA:

- Facilitates environmental exposure assessments by providing information on overall persistence, characteristic travel distance, and the transferred fraction of plastic to target compartments.
- Describes known relevant fate processes for microplastics using a reference set of equations.
- Includes a generic database of microplastic properties (e.g., size, density, and shape) to support scenario analyses for comparative assessments of plastics with varying properties.
- Uses a modular design, allowing experts to further develop the model as scientific understanding evolves. This way, parameters and process descriptions can be easily updated or replaced with new values or algorithms.
- Provides a reference modelling platform for screening-level risk assessment, calculation of hazard indicators, and identification of knowledge gaps and key drivers of uncertainty. In doing so, it supports hypothesis generation and prioritises future environmental monitoring and process studies.

The model gives insight into key microplastic properties that determine their fate in the environment. As a multicompartment mass balance tool, it divides the environment into multiple compartments (e.g. air, water, soil, sediment) and calculates how microplastic enters, leaves or stays in each compartment over time. It tracks microplastic pollution in five size classes and four aggregation states in an evaluative environment. This consists of 17 compartments representing air, freshwater, coastal water, ocean, soil, beach sand, and sediments, each structured into multiple depth or altitude layers.

DISSEMINATION

most recent

1. *SETAC Europe, Seville, May 2024.* UTOPIA: Advancing Microplastic Understanding Through Mass-Balance Based Modeling.
2. *MARII Workshop, Seattle, June 2023.* UTOPIA: A multimedia unit world open-source model for microplastic.
3. *MARII Workshop, Barcelona, October 2022.* UTOPIA: Development of an open-source, multimedia, unit world model for microplastic.

TIMELINE

RESEARCH TEAM

→ *Principal Investigator*
Dr. Matthew MacLeod, Stockholm University (SE)

→ *Collaborators*
Dr. Antonia Praetorius, University of Amsterdam (NL)
Dr. Prado Domercq, Stockholm University (SE)
Dr. Sam Harrison, UKCEH

PUBLICATIONS

→ MacLeod, M., Domercq, P., Harrison, S. et al. Computational models to confront the complex pollution footprint of plastic in the environment. Nat Comput Sci 3, 486–494 (2023).

microplastic | environmental risk assessment | open-source model

ECO57

µPLANET

Microplastic Long-range Transport Assessment and Estimation Tools

3 → Institutes

3 → Years

6 → Presentations

€298,975 → Budget

1 → Publication

A model designed to assess the long-range transport of microplastics, with a particular focus on their transfer from coastal regions to the open ocean and through the atmosphere.

HIGHLIGHTS

- Focused on atmospheric processes influencing microplastics, resulting in a mathematical framework that can estimate their transport and deposition.
- Expanded and updated the FullMulti open-source framework model (from fate and transport model project LRI-ECO48) to improve simulation of how microplastics travel through aquatic environments.
- Integrated with activities under the ongoing LRI-ECO68 microplastics Cluster-up project which brings together research results from LRI-ECO56-60.

µPLANET:

- Improves the representation of microplastic transport from coastal zones to the open ocean by refining parameterisation within the microBETR Global model (BETR: Berkeley-Trent Global Contaminant Fate Model), originally adapted for microplastics under the LRI-ECO48 project.
- Develops and applies models to simulate how microplastics are transported from rivers into the ocean, helping to assess the contribution of land-based microplastics and their trajectories. These models are incorporated into the microBETR Global framework.
- Develops Long-Range Environmental Transport (LRET) metrics for screening and prioritising microplastic properties, along with a set of environmental scenarios to support the evaluation of their LRET.
- Integrates project outputs into a flexible, modular tool that can be incorporated into the modelling framework developed under UTOPIA (LRI-ECO56).

µPLANET incorporates:

- Microplastics and nanoplastics (MNP) properties: size, shape, density and surface characteristics, including effects of environmental ageing.
- Environmental factors such as land surface properties, surface wind speed, atmospheric stratification and precipitation.

It focuses on wet and dry deposition processes, as they represent key parameters of atmospheric residence times.

Findings show that the atmospheric half-lives of microplastics —the time it takes for half of their mass or concentration in the atmosphere to be removed or degraded—can vary significantly, ranging from seconds to weeks. These atmospheric half-lives are influenced by a combination of the properties of the particle and system-dependent environmental factors such as land surface properties, surface wind speed, atmospheric stratification and precipitation.

DISSEMINATION

most recent

1. *SETAC Europe, Seville, May 2024.* Beyond the Horizon: Unveiling Transport Mechanisms and Residence Times of Atmospheric Micro & Nanoplastics.
2. *Netherlands Earth & Environmental Sciences Conference, Utrecht, March 2024.* Above and beyond: the journey and persistence of micro- and nanoplastics in the atmosphere.
3. *2024 ICCA MARII Webinar Series.* Modelling the global fate of microplastics with the long-range transport and assessment tool µPLANET.

TIMELINE

2021 | 2022 | 2023 | 2024

October — September

RESEARCH TEAM

→ *Principal Investigator*
Dr. Antonia Praetorius, University of Amsterdam (NL)

→ *Collaborators*
Todd Gouin, TG Environmental Research (UK)
Mick Whelan, University of Leicester (UK)

PUBLICATIONS

→ Seijo, M., Whelan, M.J., Gouin, T., Praetorius, A. A mechanistic approach to evaluating atmospheric deposition of micro- and nanoplastic particles. *Submitted.*

microplastic | additive leaching

ECO58

Comprehensive Additive Release and Bioaccessibility Model for Risk Assessment of Micro- and Nanoplastics in the Environment

7 → Presentations

3 → Years

2 → Research Teams

€349,725 → Budget

1 → Institute

A model to assess additive leachability from microplastics in the environment, helping to address data gaps on release behaviour.

HIGHLIGHTS

- Developed an extensive database of polymer additives.
- Made significant advances in modelling how additives are released from microplastics.
- Identified key challenges in additive leaching, including timing (temporal dynamics), transformation, and related processes.

Developing robust models to assess polymer additives in the environment is challenging due to several factors.

These include the wide molecular diversity of Polymer-Associated Chemicals (PACs), the increasing range of polymer types, sizes, and formulations, the complexity of the transport and degradation of microplastics and nanoplastics (MNP), as well as the variability in digestive conditions across exposed organisms.

To address these challenges, researchers developed an extensive database and numerical model to predict how PACs diffuse from microplastics. The model accounts for factors such as the location of the PAC within the particle (e.g. surface or core), diffusion rates, PAC concentration, and particle radius.

The model significantly advances our understanding of polymer additive and PAC behaviour in aquatic environments. It provides a valuable tool for environmental risk assessors and managers tasked with evaluating the impacts of polymer release and associated chemical exposure. The model can be adapted using both existing datasets and new data from targeted laboratory experiments.

RESEARCH TEAM

→ Prof P. Lee Ferguson, Duke University (US)
Mark R. Wiesner, Duke University (US)

TIMELINE

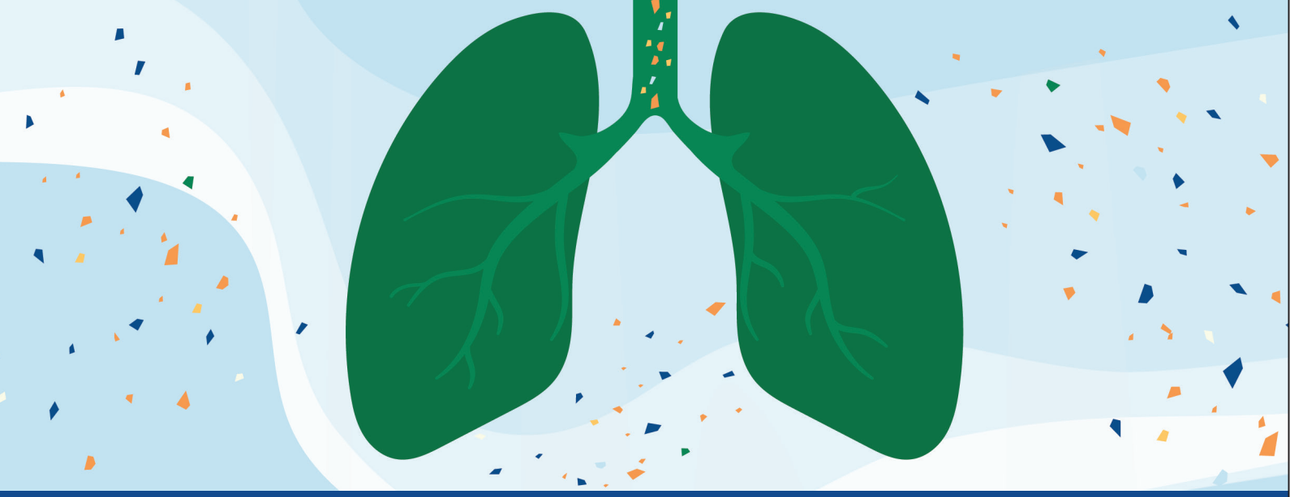
2021 | 2022 | 2023 | 2024

October — September

DISSEMINATION

most recent

1. *ACS Spring Polymer Fragmentation, New Orleans, LA, March 2024.* Modeling Fragmentation and Additive Release from Polymers and Microplastics.
2. *Society of Polymer Engineers, Galveston, TX, Feb 2024.* Modeling Fragmentation and Additive Release from Polymers and Microplastics.
3. *NanoSafe Meeting 2023.* Modeling additive release from fragmenting plastics.



microplastic | inhalation toxicity

C10

A Tiered Strategy to Assess Microplastic Inhalation

3 → Institutes

2 → Years

9 → Presentations

€800,000 → Budget

1 → Publication

Generated appropriate test materials and conducted in vitro studies to support the development of a tiered testing strategy to evaluate the inhalation toxicity of microplastics.

HIGHLIGHTS

- Developed methods to generate inhalable microplastic particles and characterised them for use in toxicity assessments.
- Established visualisation techniques to track how cells uptake particles.
- Performed in vitro testing to assess toxicity effects.

C10 advanced our understanding of inhalation toxicity of microplastics from various sources and with different properties by:

- Identifying relevant molecular, particle morphology, and particle interaction descriptors that can help predict inhalation toxicity.
- Reviewing existing particle dosimetry and assessment schemes to adapt concepts from other solid inhalable particles to microplastics.
- Establishing a tiered testing approach based on state-of the art methods using relevant, and, where possible, standardised predictive cell lines that are refined according to exposure scenarios and system complexity.
- Ranking of microplastic properties including physicochemical characteristics, distribution, dosage and biological effects according to their relevance for human risk assessments.
- Provided recommendations for future studies based on current findings.

Conclusions from C10 show the complexity of assessing inhalation toxicity of microplastics. The project addressed a critical gap in the field by improving the generation of large-scale, representative microplastic test materials. It also achieved significant progress in imaging microplastic particles within biological systems, advancing our ability to study their behaviour in the body. Furthermore, the project established in vitro test systems and defined exposure considerations, laying a strong foundation for future research in microplastic inhalation toxicity.

DISSEMINATION

most recent

1. *EUROTOX, Copenhagen, September 2024.* Visualization of polystyrene particles in Calu-3 cell cultures by stimulated Raman spectroscopy. Toxicology Letters 399(9):S5 DOI:10.1016/j.toxlet.2024.07.154
2. *SETAC Europe, Seville, May 2024.* A comprehensive study of polymer –lipid membrane interactions with in-chemico NAMs.
3. *SETAC Europe, Seville, May 2024.* Correlative Spectroscopy and Microscopy Analysis of Micro- and Nanoplastics in Complex Biological Matrices.

TIMELINE

RESEARCH TEAM

→ *Principal Investigator*
Dr. Tanja Hansen, Fraunhofer ITEM (DE)

→ *Collaborators*
Dr. Wendel Wohlleben, BASF (DE)
Prof. Dr.-Ing. Silke Christiansen, Fraunhofer IKTS (DE)

PUBLICATIONS

→ Santizo KY, Mangold HS, Mirzaei Z, Park H, Reddy Kolan R, Sarau G, Kolle S, Hansen T, Christiansen S, Wohlleben W. Microplastic Materials for Inhalation Studies: Preparation by Solvent Precipitation and Comprehensive Characterization. Small, 2025, 2405555. DOI

ECO54

Developing a tiered modeling framework in support of risk assessment of chemical substances associated with mobility concerns

2 Institutes
3.5 Years
14 Presentations
€355,872 Budget
6 Publications

Developed a tiered modeling framework to advance the risk assessment of chemical substances associated with persistence and mobility concerns.

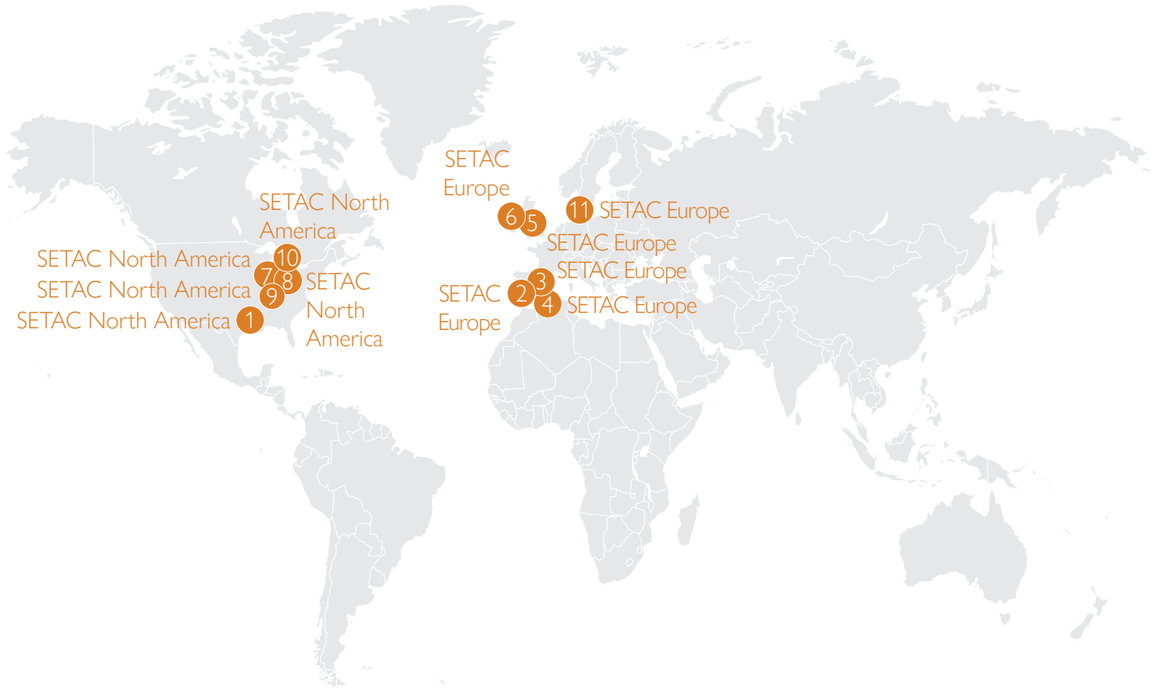
HIGHLIGHTS

- Updated RAIDAR (Risk Assessment IDentification And Ranking) model to efficiently and rapidly screen organic chemicals.
- Revised the advanced ("higher-tier") PROTEX model to estimate fate and exposure in more complex environments.
- Introduced a novel, exposure-based assessment metric, "Drinking Water Exposure Potential (DWEP)", as a practical measure of potential human exposure.

The developed tiered modelling framework was designed with the aim to:

- Develop and evaluate databases and predictive models to improve the assessment of persistence and mobility.
- Refine and improve both lower- and higher-tiered fate and exposure models (RAIDAR and PROTEX). These improvements aim to reduce uncertainty in estimating human exposure to chemical substances associated with mobility concerns via drinking water.
- Create a comprehensive assessment framework combining modelling and monitoring approaches. Its purpose is to assess time-varying exposure to chemical substances associated with mobility concerns.
- Explore conditions such as use patterns and substance properties to screen the occurrence of chemical substances in drinking water. These findings can be used for safety data communication.

The framework supports proactive identification of chemicals of concern. Its results expand the current capability of models and property prediction tools to determine chemical properties, fate and exposure levels. Findings show that a risk- or exposure- based approach can lead to more reliable and relevant outcomes for protecting human health and the environment.



DISSEMINATION

most recent

1. *SETAC North America, Fort Worth, October 2024.* Tandem Assessment of Human Exposure and Ecological Exposure Using the PROduction-To-EXposure (PROTEX) Model.
2. *SETAC Europe, Seville, May 2024.* Should we assess the P&M chemicals from a perspective of the "hazard" or "exposure"?
3. *SETAC Europe, Seville, May 2024.* Fate and Exposure Modeling of PMT/vPvM Substances using PROTEX.

TIMELINE

2021 2022 2023 2024

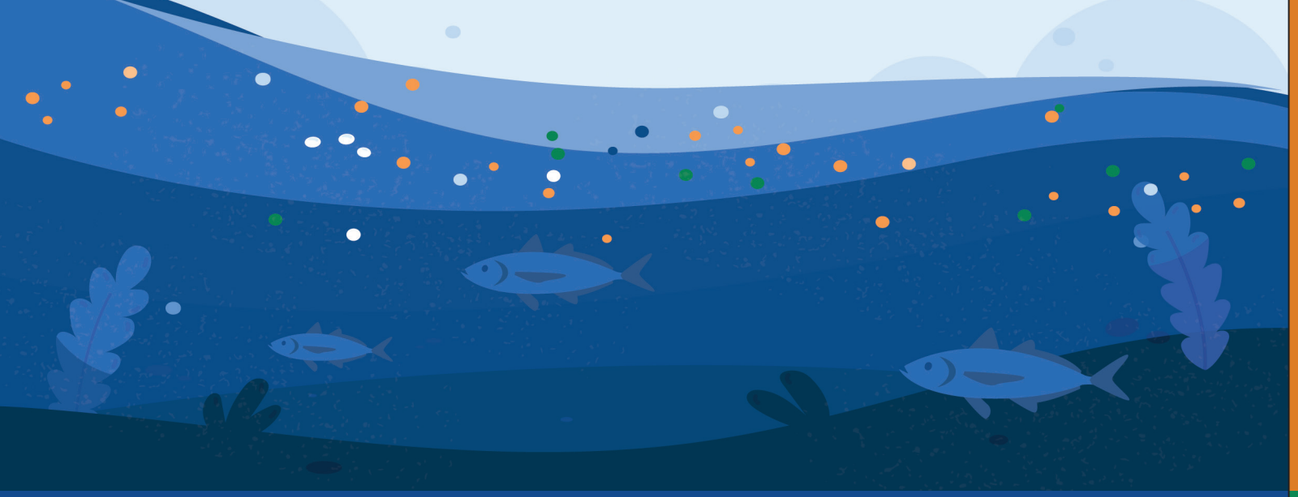
April — September

RESEARCH TEAM

- *Principal Investigator*
  Dr. Li Li, University of Nevada, Reno (US)
- *Collaborators*
  Dr. Jon A Arnot, Dr. Trevor Brown, and Alessandro Sangion, Arnot Research and Consulting Inc. (ARC) (CA)

PUBLICATIONS

- Zhang, Z., Sangion, A., Wang, S., Gouin, T., Brown, T. N., Arnot, J. A., Li, L. Chemical space covered by applicability domains of quantitative structure–property relationships and semiempirical relationships in chemical assessments. *Environ. Sci. Technol.* 2024, 58, 3386–3398.
- Zhang, Z., Sangion, A., Wang, S., Gouin, T., Brown, T. N., Arnot, J. A., Li, L. Hazard vs. exposure: Does it make a difference in identifying chemicals with persistence and mobility concerns? *Water Res.* 2023, 245, 120610.
- Zhang, Z., Wang, S., Brown, T. N., Sangion, A., Arnot, J. A., Li, L. Modeling sorption of environmental organic chemicals from water to soils, *Water Res. X.* 2024, 22, 100219.



ECO65

Characterizing the uncertainty in MAF values for aquatic receptors estimated using the KEMI MAF

2 → Institutes

1 → Year

1 → Presentation

€50,000 → Budget

1 → Publication

A recent report by the Swedish Chemicals Agency (KEMI) proposed a methodology for deriving Mixture Assessment or Allocation Factor (MAF) values. These are safety factors used to account for combined exposure to multiple chemicals. While the KEMI approach represents an improvement over previous methods, particularly in how it models the effect of MAFs in reducing combined exposures, it also has limitations.

ECO65 examines the uncertainty and variability in MAF values for chemical mixtures detected in surface waters. The study identified biases in the KEMI methodology and demonstrated how these biases affect MAF estimates, using data from a wide range of mixtures measured across multiple surveys. Using existing data, the study provided clear, evidence-based support for using alternative assumptions than the ones used in the original KEMI method.

DISSEMINATION

SETAC Europe, Seville, May 2024. Impact of exposure assumptions on the size of mixture assessment factors required to protect environmental receptors.

RESEARCH TEAM

Dr. Paul Price, Risk Sciences International
Dr. Ismael M. Rodea Palomares, Bayer US Crop Science

PUBLICATIONS

Price, P., Rodea-Palomares, I., Weyers, A. Assessing the impact of different assumptions on the size of a Mixture Assessment Factor (MAF) for chemical mixtures in surface waters using data from three recent monitoring studies. Sci. of the Tot. Env. 956, 176703 (2024).

TIMELINE

2023 — September

2024 — April

ANP1

Systematic literature review on analytical methods for the determination of PFAS

1 → Institute

1 → Year

2 → Publications

€47,800 → Budget

ANP1 focused on extensive literature reviews to document the wide range of methods that are used for the determination of per- and polyfluoroalkyl substances (PFAS). The reviews focused on the scientific literature and follow the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidance. PRISMA is the preferred method for systematic literature review as it removes potential bias. To provide a more comprehensive overview of current analytical practices, the study also included a review of "grey literature" (e.g., reports, theses, and regulatory documents).

Two literature reviews—one on non-targeted analysis and the other on total PFAS analysis—were published, drawing from more than 250 articles in total. A key finding was that non-targeted and total analysis methods, when used alongside targeted analysis, provide a complementary approach for understanding PFAS in the environment and identifying research gaps.

RESEARCH TEAM

Dr. David Megson, Chemistry Matters

PUBLICATIONS

Megson, D., Bruce-Vanderpuije, P., Idowu, I.G. et al. A systematic review for non-targeted analysis of per- and polyfluoroalkyl substances (PFAS). Sci TotEnv 960, 178240 (2025). https://doi.org/10.1016/j.scitotenv.2024.178240

Idowu, I.G., Ekpe, O.D., Megson, D. et al. A systematic review of methods for the analysis of total per- and polyfluoroalkyl substances (PFAS). Sci Tot Env 967, 178644 (2025). https://doi.org/10.1016/j.scitotenv.2025.178644

TIMELINE

2024 — January — September

LRI
Long-Range
Research Initiative

cefic

LONG-RANGE RESEARCH INITIATIVE
CEFIC AISBL
Rue Belliard 40 1040 Brussels Belgium
www.cefic-lri.org
EU Transparency Register n° 64879142323-90

Contact:
Katherine Santizo, LRI Programme Manager
lri@cefic.be